

Creating Modern Cometary Models using Ancient Chinese Data

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For more than two millennia, ancient Chinese court astronomers maintained a rather comprehensive record of cometary sightings. Owing to the significance of comets as portents for the reigning emperor, early sky watchers from China (as well as their counterparts from Korea and Japan) carefully noted each cometary apparition for the purpose of astrological predictions. When possible, the dates and corresponding celestial locations and motions were recorded and in some cases, the colors, coma sizes, and tail lengths were also noted. These ancient Chinese observations represent the only source of information available for modeling the long-term behavior of periodic comets. For comets Halley and Swift-Tuttle, Chinese records have been identified as far back as 240 B.C. and 69 B.C. respectively and these data have been used to define their long-term motions. As a result, cometary heliocentric and geocentric distances for each Chinese sighting of these two comets can be computed and estimates can be made for each comet's intrinsic brightness at various observed returns. For both comets Halley and Swift-Tuttle, their absolute magnitudes, and hence their outgassing rates, have remained relatively constant for two millennia. For comet Halley, this outgassing takes place preferentially after perihelion when localized active regions are exposed to sunlight. This outgassing pattern, which consistently delays the comet's return by 4 days per period, requires that the spin state of Halley's nucleus be relatively stable over many orbital revolutions. For the nucleus of comet Swift-Tuttle, we conclude that its mass is at least an order of magnitude larger than comet Halley because, while its outgassing rate is comparable to Halley's nucleus, its motion is unaffected by rocket-like outgassing accelerations. Although the earliest identified apparition of comet Tempel-Tuttle is A.D. 1366, the associated Leonid meteor showers were noted back to at least A.D. 902. The Leonid meteor stream is young in the sense that outstanding meteor displays occur only near the time of the parent comet's perihelion passages. The ancient Chinese records of the Leonid meteor showers and storms have been used to map the particle distribution around the parent comet and this information was used to guide predictions for the 1998-1999 Leonid meteor showers.